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GB 761207

GB 759691

GB 747720

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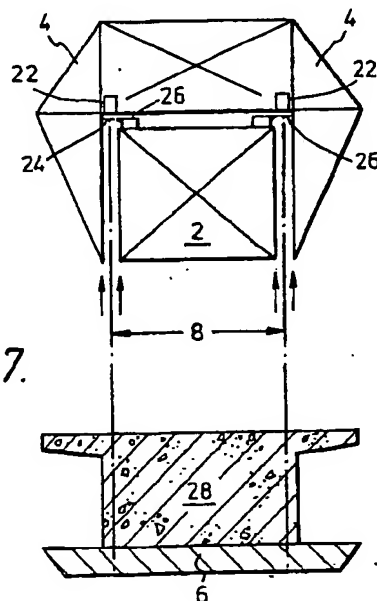
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(54) Apparatus for use in concreting multiple section elevated structures

(57) Apparatus for use in concreting multiple section elevated structures, e.g. bridges, of the type which includes a scaffolding girder (4) to be supported above the section to be concreted from which is suspended shuttering (6) for supporting the concrete, additionally comprises means (24, 26) for detecting the displacement of the shuttering for supporting the concrete from a predetermined position and adjusting means (22) for adjusting the shuttering (6) from a displaced position to said predetermined position. The detection means may comprise a fixed reference point 26 and a moveable reference point which is displaced by the load exerted during concreting.

The adjusting means 22, which may be operated by the detection means, may comprise a piston assembly or worm gear which are operative to raise or lower hangers 8 to which the shuttering (6) is secured.

Fig. 7.



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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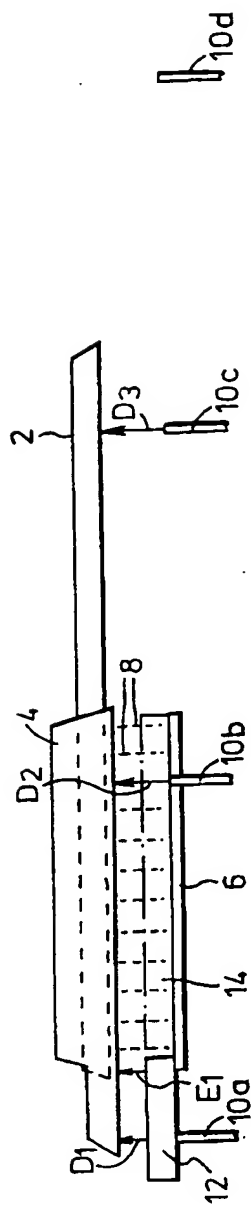
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Fig. 1.

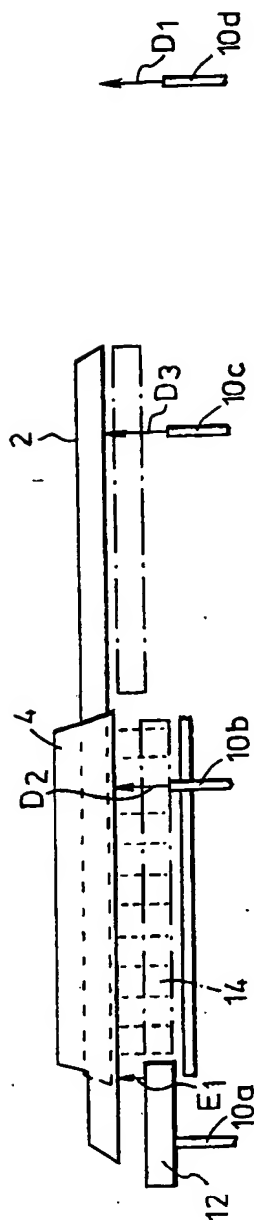


Fig. 2.

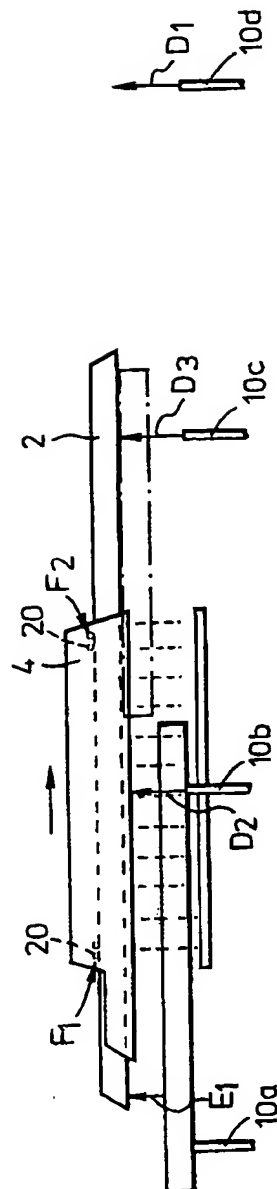
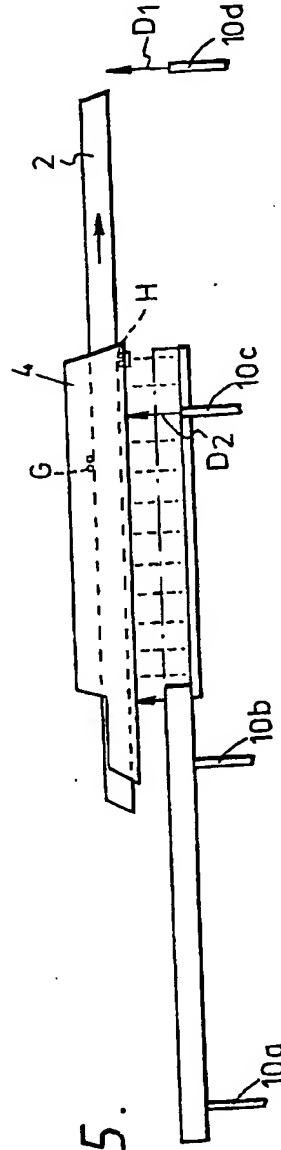
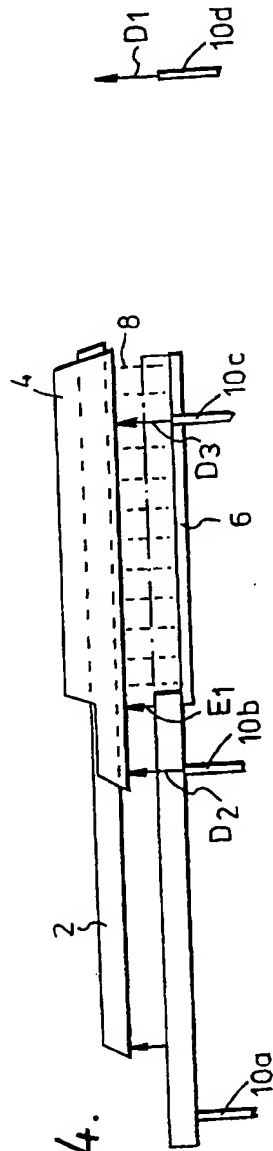


Fig. 3.

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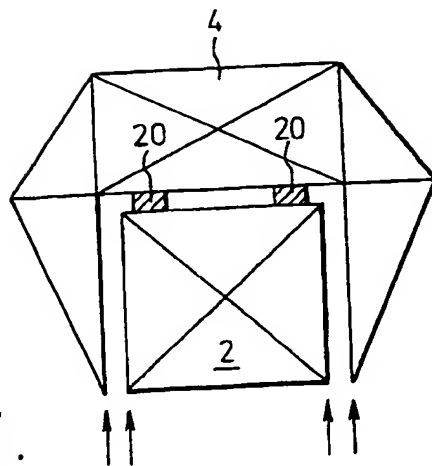


Fig. 6.

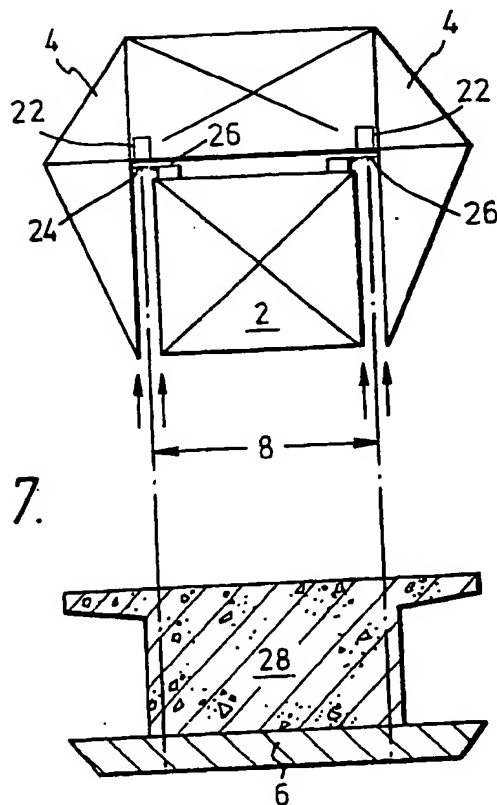


Fig. 7.

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## SPECIFICATION

## Apparatus for use in concreting multiple section elevated structures

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This invention relates to apparatus for use in the construction of multiple section elevated structures of reinforced or pre-stressed concrete. The invention is particularly applicable in the construction of elevated highways and bridges.

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Known apparatus for concreting multiple sections of elevated structures comprises an overhead scaffolding girder, which extends over the section to be concreted and is supported at each end, from which the shuttering for supporting the concrete is suspended by a series of hangers.

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One type of such apparatus comprises two girders or gantries which are longitudinally displaceable relative to one another, one of which is a scaffolding girder from which the shuttering for supporting the concrete is suspended and the other is an advancing or launching girder for supporting the scaffolding girder while it is advanced from a completed section to the next section to be concreted during the construction process. Such apparatus is disclosed, for example, in United States Patent Specification No. 3 003 219 and Canadian Patent Specification No. 873,604.

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One of the problems associated with this type of apparatus is that the load exerted by the concrete during casting and drying tends to cause displacement of the shuttering supporting the concrete. This displacement is caused primarily by the deflecting or bowing of the girder or girders from which the shuttering is suspended under the weight of the concrete. The problem is particularly marked when the section being cast is of considerable length. The solution to this problem is hampered by the fact that the displacement is not uniform throughout the length of the section, for example, when the supporting girder bows, there may be considerable displacement at the centre of the section and little or no displacement towards the ends.

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A known method of compensating for such displacement is to arrange the shuttering such that after displacement under the load of concrete the shuttering is at the desired position. In practice, this means that the shuttering in the unloaded state is cambered. This method is not entirely satisfactory since the deflection of the shuttering must be accurately calculated, and the construction of the shuttering is necessarily complex to produce the required camber. Furthermore, the amount of cambering must be recalculated for each different length of section to be cast.

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It is an object of the present invention to provide apparatus in which the problem of shuttering displacement during concreting

may be substantially reduced or overcome.

According to the present invention there is provided apparatus for use in concreting multiple section elevated structures of the type which includes a scaffolding girder to be supported above the section to be concreted from which is suspended shuttering for supporting the concrete, the apparatus additionally comprising means for detecting the displacement of the shuttering for supporting the concrete from a predetermined position and adjusting means for adjusting the shuttering from a displaced position to said predetermined position.

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The apparatus of the invention overcomes the problem of displacement of the shuttering during concreting in a relatively simple manner. The shuttering is initially adjusted to the desired alignment for concreting. The apparatus includes detecting means which will indicate when the shuttering is displaced from the desired position. The apparatus also includes adjusting means, such as hydraulic jacks, whereby the shuttering may be moved to compensate for the displacement.

The invention is applicable to all types of apparatus in which the shuttering is suspended from an overhead girder or gantry. Preferably, the apparatus includes both a launching girder and scaffolding girder to facilitate movement of the apparatus from one section to the next.

In one embodiment of the invention, the shuttering is supported from the scaffolding girder or gantry by a series of hangers or suspenders. When the shuttering is in the desired position, a reference point on each hanger is aligned with a reference or data point which will not be subject to displacement during concreting, e.g. the launching girder, thus when the shuttering is displaced the reference points will be displaced from the aligned position. Each hanger is connected to adjusting means, for example, a hydraulic piston and cylinder assembly, whereby the hanger may be raised or lowered relative to the scaffolding girder. By suitable operation of the adjusting means each hanger may be raised until the two reference points are realigned. This operation is repeated for all the hangers thereby adjusting the shuttering to the desired position.

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The detecting means serves to indicate displacement of the shuttering and includes a fixed reference point which is not displaced during concreting and a moveable reference point which will be displaced when the shuttering is displaced. The fixed and moveable points are adjusted to a known relationship, e.g. aligned, when the shuttering is correctly positioned and any displacement of the shuttering causes deviation from the known relationship. The adjusting means are then operated until the reference points resume their correct relationship.

The fixed reference point may be mounted on part of the apparatus which is not subjected to load during concreting, e.g. the launching girder, and may simply take the form of a painted line. The fixed reference point may also take the form of a stretched wire, a light beam, e.g. from a laser, or similar optical device.

The moveable reference point is conveniently mounted on each hanger so that displacement throughout the length of the section being concreted may be observed and corrected, e.g. by varying the length of the hangers.

The detection means may simply act as a visual indication that displacement has occurred and the adjusting means operated separately. Alternatively the detection means may automatically initiate operation of the adjusting means, e.g. by providing electrical contacts as the reference points so that circuits are made or broken upon displacement.

The adjusting means may comprise any suitable apparatus which will raise or lower the hanger, preferably a hydraulic assembly may be utilized in which the hanger may be connected to a piston assembly operated by hydraulic fluid. Other apparatus may also be used for raising or lowering the hangers, for example, rack and pinion assemblies, worm gear assemblies and the like.

The invention will now be illustrated with reference to the accompanying drawings, in which:

Figures 1 to 5 represent side views of apparatus of the invention in different phases,

Figure 6 represents an end view of the launching and scaffolding gantries, and

Figure 7 represents a cross-section of apparatus in accordance with the invention.

The apparatus of the invention comprises a launching gantry or girder 2 upon which is mounted a scaffolding gantry or girder 4 from which is suspended the false work comprising the shuttering 6 by hangers 8. The structure under construction includes a series of supports or pillars 10a, 10b, 10c, 10d upon which the elevated concrete section is to be supported. A previously cast concrete section is shown at 12.

Fig. 1 shows the apparatus adjusted ready for concreting a new section 14 shown in dotted outline. The scaffolding gantry 4 is supported by a temporary support at  $D_2$  on pillar 10b and a back support  $E_1$  on the previously cast concrete section 12. The launching gantry 2 which is in its forward position is supported at  $D_1$  and  $D_3$  from pillars 10a and 10c respectively. The shuttering 6 is aligned in the desired position for concreting.

After the concrete has set, the shuttering 6 is loaded into its travelling position as shown in Fig. 2. The support  $D_1$  is moved from pillar 10a to pillar 10d ready for advance of the apparatus.

The scaffolding gantry 4 is propelled along launching gantry 2 supported on a roller at  $D_2$  and counterbalanced by hydraulically sprung rollers 20 on the launching gantry at  $F_1$  and  $F_2$ , as shown in Figs. 3 and 6. The shuttering 6 moves together with the scaffolding gantry 4.

Fig. 4 shows the apparatus with the scaffolding gantry 4 positioned over the next section to be concreted and the shuttering 6 positioned for the next concrete pour. The scaffolding gantry is supported at  $D_3$  and by a back support  $E_1$  which has been repositioned to the end of the last concreted section. Thus, the load of the scaffolding gantry 4 is taken off launching gantry 2.

The launching gantry 2 is then propelled forward on rollers at  $D_2$  and counterbalanced against the scaffolding gantry through rollers positioned at G. Alternatively rollers at the support  $D_2$  may be replaced by rollers at H. The nose of the launching gantry 2 is advanced passed pillar 10d where it is supported at  $D_1$  by rollers which may be hydraulically raised. The scaffolding gantry 4 supporting the shuttering 6 remains stationary during this operation ready for the concrete pour.

Fig. 7 shows the cross-section through the apparatus illustrating one embodiment of the detecting and adjusting means. The hangers 8 which attach the false work or shuttering 6 to the scaffolding gantry 4 are mounted to the scaffolding gantry 4 through hydraulic piston and cylinder assemblies 22. Each hanger is provided with a reference point 24 which is aligned with a reference point or data line 26 on the launching gantry 2 when the shuttering 6 is in the correct position for receiving concrete. When the concrete is cast to form section 28 the load exerted causes the scaffolding gantry to deflect. This deflection is recorded by movement of the reference points 24 in relation to the corresponding reference point 26. The displacement may be counteracted by raising the hangers 8 by the hydraulic piston and cylinder assemblies 22 until the reference points 24 and 26 are realigned. The hanger are preferably spaced regularly, e.g. 2½ metres apart, throughout the length of the section and each hanger or pair of hangers is preferably provided with detecting and adjusting means. The level of the false work or shuttering may be adjusted very accurately along the entire length of the section being constructed.

#### CLAIMS

1. Apparatus for use in concreting multiple section elevated structures of the type which includes a scaffolding girder to be supported above the section to be concreted from which is suspended shuttering for supporting the concrete, the apparatus additionally comprising means for detecting the displacement of the shuttering for supporting the

concrete from a predetermined position and adjusting means for adjusting the shuttering from a displaced position to said predetermined position.

- 5 2. Apparatus as claimed in Claim 1 which is of the type comprising a launching girder for supporting the scaffolding girder when it is advanced from a concreted section to a section to be concreted.

- 10 3. Apparatus as claimed in Claim 1 or Claim 2 in which hangers supporting the shuttering from the scaffolding gantry may be raised or lowered by said adjusting means.

4. Apparatus as claimed in any preceding claim in which said adjusting means comprises a hydraulic piston and cylinder assembly.

5. Apparatus as claimed in any preceding claim in which the detecting means comprises  
20 a fixed reference point which does not move during concreting and a movable reference point which is displaced upon displacement of the shuttering, the fixed and moveable reference points being in a known relationship  
25 when the shuttering is in its predetermined position.

6. Apparatus as claimed in Claim 5 in which the hangers are provided with a moveable reference point which when the shuttering  
30 is in the desired position is aligned with the fixed reference point.

7. Apparatus as claimed in any preceding claim in which the detecting means is adapted to operate the adjusting means to automatically compensate for any displacement.  
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8. Apparatus as claimed in any preceding claim in which the hangers are spaced regularly apart throughout the length of the shuttering, each hanger being provided with detecting and adjusting means.  
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9. Apparatus for use in concreting multiple section elevated structures as claimed in Claim 1 substantially as herein described with reference to the accompanying drawings.

- 45 10. A method of concreting a section of a multiple section elevated structure utilizing the apparatus as claimed in any preceding claim, which comprises the steps of:

- (1) positioning the shuttering for receiving  
50 the concrete to its desired position,  
(2) casting said concrete,  
(3) recording any displacement of the shuttering on said detecting means, and  
(4) operating the adjusting means to re-  
55 store the shuttering to its desired position.

11. A method for concreting a section of a multiple section elevated structure as claimed in Claim 10 substantially as herein described with reference to the accompanying drawings.

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